#3

Claims

64. (New) An apparatus for generating a signal representative of force, the apparatus comprising:

a receiver for receiving a signal representative of a location of a user reference point relative to a user reference frame;

a geometrical model storing:

a representation of a non-local reference frame;

the user reference frame in relation to the non-local reference frame; and

a conformation of a non-local environment, the conformation comprising a spring-type element relative to the non-local reference frame;

a comparator for comparing the location of the user reference point relative to the non-local environment; and

a force generator for generating a signal representative of a force based on the location of the user reference point relative to the non-local environment and at least one force rule.

65. (New) The apparatus of claim 64, wherein the at least one force rule comprises a spring-force rule which specifies an output force signal in response to a location signal of the user reference point indicative of a deflected conformation of the spring-type element.

66. (New) The apparatus of claim 65, wherein the output force signal is specified by a non-linear function.

67. (New) The apparatus of claim 64, further comprising a non-local environment reaction calculator that makes changes to the representation of the conformation of the non-local environment based on the signal representative of force and the at least one force rule.

68. (New) The apparatus of claim 67, wherein the at least one force rule specifies a change in a representation of the conformation of the non-local environment in response to a location signal of the user reference point indicative of a deflected conformation of the spring-type element.

69. (New) The apparatus of claim 64, wherein the spring-type element is selected from the group consisting of a switch element and a diagonal element.

70. (New) The apparatus of claim 69, wherein the switch element is selected from the group consisting of a virtual push-button and a virtual toggle-type switch.

a force generator for generating a signal representative of a force based on the location of the user reference point relative to the non-local environment and at least one force rule.

65. (New) The apparatus of claim 64, wherein the at least one force rule comprises a spring-force rule which specifies an output force signal in response to a location signal of the user reference point indicative of a deflected conformation of the spring-type element.

66. (New) The apparatus of claim 65, wherein the output force signal is specified by a non-linear function.

67. (New) The apparatus of claim 64, further comprising a non-local environment reaction calculator that makes changes to the representation of the conformation of the non-local environment based on the signal representative of force and the at least one force rule.

68. (New) The apparatus of claim 67, wherein the at least one force rule specifies a change in a representation of the conformation of the non-local environment in response to a location signal of the user reference point indicative of a deflected conformation of the spring-type element.

69. (New) The apparatus of claim 64, wherein the spring-type element is selected from the group consisting of a switch element and a diagonal element.

70. (New) The apparatus of claim 69, wherein the switch element is selected from the group consisting of a virtual push-button and a virtual toggle-type switch.

71. (New) The apparatus of claim 69, wherein the diagonal element is selected from the group consisting of a brush, a sponge, and an eraser.

72. (New) The apparatus of claim 71, further comprising a non-local environment reaction calculator that makes changes to the representation of the conformation of the non-local environment based on the signal representative of force and the at least one force rule, wherein a diagonal element spring-type rule specifies a change in a representation of a cross-sectional area of a selected region of the diagonal element.

73. (New) A method for generating a signal representative of force, the method comprising the steps of:

receiving a signal representative of a location of a user reference point relative to a user reference frame;

storing a representation of:

a non-local reference frame,

the user reference frame in relation to the non-local reference frame; and

a conformation of a non-local environment, the conformation comprising a spring-type element relative to the non-local reference frame;

comparing the location of the user reference point relative to the non-local environment; and

generating a signal representative of a force based on the location of the user reference point relative to the non-local environment and at least one force rule.

74. (New) The method of claim 73 further comprising the step of changing a representation of the conformation of the non-local environment based on the signal representative of force and the at least one force rule.

75. (New) The method of claim 74, further comprising the step of displaying on a visual display the representation of the conformation of the non-local environment as the representation changes over time.

76. (New) A force reflecting haptic interface comprising:

an electro-mechanical device comprising:

a connection element for physically coupling to a user;

an actuator including an encoder; and

a linkage mechanism coupling the connection element to the actuator;

an electrical input/output device; and

a control apparatus for generating an output force signal and an output position signal.

77. (New) The interface of claim 76, wherein the linkage mechanism comprises a series of rotary elements.

78. (New) The interface of claim 76, wherein the linkage mechanism comprises a five-bar linkage.

79. (New) The interface of claim 76, wherein the actuator comprises a rotary actuator.

71. (New) The apparatus of claim 69, wherein the diagonal element is selected from the group consisting of a brush, a sponge, and an eraser.

72. (New) The apparatus of claim 71, further comprising a non-local environment reaction calculator that makes changes to the representation of the conformation of the non-local environment based on the signal representative of force and the at least one force rule, wherein a diagonal element spring-type rule specifies a change in a representation of a cross-sectional area of a selected region of the diagonal element.

73. (New) A method for generating a signal representative of force, the method comprising the steps of:

receiving a signal representative of a location of a user reference point relative to a user reference frame;

storing a representation of:

a non-local reference frame,

the user reference frame in relation to the non-local reference frame; and

a conformation of a non-local environment, the conformation comprising a spring-type element relative to the non-local reference frame;

comparing the location of the user reference point relative to the non-local environment; and

generating a signal representative of a force based on the location of the user reference point relative to the non-local environment and at least one force rule.

74. (New) The method of claim 73 further comprising the step of changing a representation of the conformation of the non-local environment based on the signal representative of force and the at least one force rule.

75. (New) The method of claim 74, further comprising the step of displaying on a visual display the representation of the conformation of the non-local environment as the representation changes over time.

76. (New) A force reflecting haptic interface comprising:

an electro-mechanical device comprising:

a connection element for physically coupling to a user;

an actuator including an encoder; and

a linkage mechanism coupling the connection element to the actuator;

an electrical input/output device; and

a control apparatus for generating an output force signal and an output position signal.

77. (New) The interface of claim 76, wherein the linkage mechanism comprises a series of rotary elements.

78. (New) The interface of claim 76, wherein the linkage mechanism comprises a five-bar linkage.

79. (New) The interface of claim 76, wherein the actuator comprises a rotary actuator.

80. (New) The interface of claim 76, wherein the electro-mechanical device converts an input force signal and an input position signal to a torque value and an angle measurement, respectively.

81. (New) The interface of claim 76, wherein the control apparatus comprises a computer.

82. (New) The interface of claim 76, wherein the control apparatus generates the output force signal based at least in part on an electrical signal that represents an amount of torque the actuator applies in a local environment.